TECHNICAL SPECIFICATION

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Photography and graphic technology — Extended colour encodings for digital image storage, manipulation and interchange —

Part 3: Reference input medium metric RGB colour image encoding (RIMM RGB)

Photographie et technologie graphique — Codages par couleurs étendues pour stockage, manipulation et échange d'image numérique — Partie 3: Codage d'image en couleurs RVB par référence d'entrée par voie métrique

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Contents

Page

Foreword

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In other circumstances, particularly when there is an urgent market requirement for such documents, a technical committee may decide to publish other types of document:

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An ISO/PAS or ISO/TS is reviewed after three years in order to decide whether it will be confirmed for a further three years, revised to become an International Standard, or withdrawn. If the ISO/PAS or ISO/TS is confirmed, it is reviewed again after a further three years, at which time it must either be transformed into an International Standard or be withdrawn.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TS 22028-3 was prepared by Technical Committee ISO/TC 42, *Photography*.

This second edition cancels and replaces the first edition (ISO/TS 22028-3:2006), which has been technically revised.

ISO/TS 22028 consists of the following parts, under the general title *Photography and graphic technology — Extended colour encodings for digital image storage, manipulation and interchange*:

— *Part 1: Architecture and requirements*

— *Part 2: Reference output medium metric RGB colour image encoding (ROMM RGB)*

— *Part 3: Reference input medium metric RGB colour image encoding (RIMM RGB)* [Technical Specification]

The following parts are under preparation:

— *Part 4: European Colour Initiative RGB colour image encoding [eciRGB (2008)]* [Technical Specification]

Introduction

This part of ISO 22028 has been developed in order to meet the industry need for a complete, fully-documented, publicly-available definition of a wide-primary scene-referred extended colour gamut red-green-blue (RGB) colour image encoding. This encoding provides a way to represent scene-referred images that does not limit the colour gamut to those colours capable of being displayed on a CRT monitor, or require the use of negative RGB colourimetry coordinates.

A scene-referred extended colour gamut colour encoding is particularly desirable for professional photography applications. For example, colours captured by digital cameras, as well as conventional capture devices such as photographic film, can be outside those that can be represented within the colour gamut of a typical monitor or other types of output devices. Similarly, scene-referred images can have a larger luminance dynamic range than output-referred images since they have not been modified by a colour rendering process to fit the images to a specific output medium applying appropriate tone and colour reproduction aims. Retaining the unrendered scene-referred image data has the advantage that it preserves the option to make decisions about how a particular image is to be rendered. For example, a scene-referred image of a backlit scene can retain information about both the dark foreground region and the bright background region of the scene. This information can be used to make a properly exposed print of either the foreground region or the background region, or alternatively can be used to create an improved image by rendering the two regions differently.

By using a standard scene-referred extended colour gamut colour image encoding, images can be stored, interchanged and manipulated without restricting the image to a particular rendering intent or output device. The reference input medium metric RGB (RIMM RGB) colour encoding specified in this part of ISO 22028 meets the needs of these types of applications. An extended dynamic range version of this colour image encoding known as extended reference input medium metric RGB (ERIMM RGB), and a floating point version known as FP-RIMM RGB are also specified for use with high-dynamic range input sources. The scene-referred RIMM RGB colour image encoding is intended to be complementary to the output-referred ROMM RGB colour image encoding specified in ISO/TS 22028-2. Both colour encodings are based on the same “wide RGB” additive colour space to facilitate the development of image processing algorithms and simple colour rendering transformations to convert scene-referred RIMM RGB images to rendered output-referred ROMM RGB images.

The International Organization for Standardization (ISO) draws attention to the fact that it is claimed that compliance with this document may involve the use of patents concerning extended range colour encodings given in 4.4 and 4.5. ISO takes no position concerning the evidence, validity and scope of this patent right.

The holder of this patent right has assured ISO that he/she is willing to negotiate licences under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holder of this patent right is registered with ISO. Information may be obtained from

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Photography and graphic technology — Extended colour encodings for digital image storage, manipulation and interchange —

Part 3: Reference input medium metric RGB colour image encoding (RIMM RGB)

1 Scope

This part of ISO 22028 specifies a family of scene-referred extended colour gamut RGB colour image encodings designated as reference input medium metric RGB (RIMM RGB). Digital images encoded using RIMM RGB can be manipulated, stored, transmitted, displayed or printed by digital still picture imaging systems. Three precision levels are defined using 8-, 12- and 16-bits/channel.

An extended luminance dynamic range version of RIMM RGB is also defined, designated as extended reference input medium metric RGB (ERIMM RGB). Two precision levels of ERIMM RGB are defined using 12- and 16-bits/channel.

FP-RIMM RGB, a floating point version of RIMM RGB, defines the expression method of RIMM RGB in a floating point figure. Three precision levels of FP-RIMM RGB are defined using 16-, 32- and 64-bits/channel.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 12234-2, *Electronic still-picture imaging — Removable memory — Part 2: TIFF/EP image data format*

ISO 22028-1:2004, *Photography and graphic technology — Extended colour encodings for digital image storage, manipulation and interchange — Part 1:Architecture and requirements*

ISO 11664-1, *Colorimetry — Part 1: CIE standard colorimetric observers*[1)]

CIE Publication 15, *Colorimetery*

IEEE 754, *IEEE Standard for Floating-Point Arithmetic*

1) Replaces ISO/CIE 10527.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
adapted white
colour stimulus that an observer who is adapted to the viewing environment would judge to be perfectly achromatic and to have a luminance factor of unity; i.e. absolute colourimetric coordinates that an observer would consider to be a perfect white diffuser

NOTE The adapted white can vary within a scene.

3.2
additive RGB colour space
colourimetric colour space having three colour primaries (generally red, green and blue) such that CIE XYZ tristimulus values can be determined from the RGB colour space values by forming a weighted combination of the CIE XYZ tristimulus values for the individual colour primaries, where the weights are proportional to the radiometrically linear colour space values for the corresponding colour primaries

NOTE 1 A simple linear 3 × 3 matrix transformation can be used to transform between CIE XYZ tristimulus values and the radiometrically linear colour space values for an additive RGB colour space.

NOTE 2 Additive RGB colour spaces are defined by specifying the CIE chromaticity values for a set of additive RGB primaries and a colour space white point, together with a colour component transfer function.

3.3
adopted white

spectral radiance distribution as seen by an image capture or measurement device and converted to colour signals that are considered to be perfectly achromatic and to have an observer adaptive luminance factor of unity; i.e. colour signals that are considered to correspond to a perfect white diffuser

NOTE 1 The adopted white can vary within a scene, if such variation is supported by the imaging system.

NOTE 2 The adopted white is not required to be an estimate or approximation of the adapted white. For example, if a scene lit by tungsten illumination is captured using a DSC with the white balance set to D55 (daylight), the adopted white will be D55 but the adapted white will be closer to a tungsten illuminant (e.g. ISO 7589 Studio Tungsten or CIE Illuminant A).

NOTE 3 See 3.1.

3.4
colourimetric colour space
colour space having an exact and simple relationship to CIE colourimetric values

NOTE Colourimetric colour spaces include those defined by CIE (e.g. CIE XYZ, CIELAB, CIELUV), as well as colour spaces that are simple transformations of those colour spaces (e.g. additive RGB colour spaces).

3.5
colour component transfer function
single variable, monotonic mathematical function applied individually to one or more colour channels of a colour space

NOTE 1 Colour component transfer functions are frequently used to account for the nonlinear response of a reference device and/or to improve the visual uniformity of a colour space.

NOTE 2 Generally, colour component transfer functions will be nonlinear functions such as a power-law (i.e. "gamma") function or a logarithmic function. However, in some cases a linear colour component transfer function can be used.

3.6
colour encoding
generic term for a quantized digital encoding of a colour space, encompassing both colour space encodings and colour image encodings

3.7
colour gamut
solid in a colour space, consisting of all those colours that are either present in a specific scene, artwork, photograph, photomechanical, or other reproduction, or capable of being created using a particular output device and/or medium

3.8
colour image encoding
digital encoding of the colour values for a digital image, including the specification of a colour space encoding, together with any information necessary to properly interpret the colour values such as the image state, the intended image viewing environment and the reference medium

NOTE 1 In some cases, the intended image viewing environment will be explicitly defined for the colour image encoding. In other cases, the intended image viewing environment can be specified on an image-by-image basis using metadata associated with the digital image.

NOTE 2 Some colour image encodings will indicate particular reference medium characteristics, such as a reflection print with a specified density range. In other cases, the reference medium will not be applicable, such as with a scene-referred colour image encoding, or will be specified using image metadata.

NOTE 3 Colour image encodings are not limited to pictorial digital images that originate from an original scene, but are also applicable to digital images with content such as text, line art, vector graphics and other forms of original artwork.

3.9
colour rendering
mapping of image data representing the colour-space coordinates of the elements of a scene to output-referred image data representing the colour space coordinates of the elements of a reproduction

NOTE Colour rendering generally consists of one or more of the following:

— compensating for differences in the input and output viewing conditions;

— tone scale and gamut mapping to map the scene colours onto the dynamic range and colour gamut of the reproduction;

— applying preference adjustments.

3.10
colour space
geometric representation of colours in space, usually of three dimensions

[CIE Publication 17.4:1987, 845-03-25]

3.11
colour space encoding
digital encoding of a colour space, including the specification of a digital encoding method, and a colour space value range

NOTE Multiple colour space encodings can be defined based on a single colour space where the different colour space encodings have different digital encoding methods and/or colour space value ranges. (For example, 8-bit sRGB and 10-bit e-sRGB are different colour space encodings based on a particular RGB colour space.)

3.12
colour space white point
colour stimulus to which colour space values are normalized

NOTE It is not necessary that the colour space white point correspond to the assumed adapted white point and/or the reference medium white point for a colour image encoding.

3.13
image state
attribute of a colour image encoding indicating the rendering state of the image data

NOTE The primary image states defined in this document are the scene-referred image state, the original-referred image state and the output-referred image state.

3.14
luminance factor
ratio of the luminance of the surface element in the given direction to that of a perfect reflecting or transmitting diffuser identically illuminated

[CIE Publication 17.4:1987, 845-04-69]

3.15
observer adaptive luminance factor
ratio of the luminance of a stimulus to the luminance of a stimulus that an observer adapted to the viewing environment would interpret to be a perfect white diffuser

3.16
output-referred image state
image state associated with image data that represents the colour space coordinates of the elements of an image that has undergone colour rendering appropriate for a specified real or virtual output device and viewing conditions

NOTE 1 When the phrase "output-referred" is used as a qualifier to an object, it implies that the object is in an output-referred image state. For example, output-referred image data are image data in an output-referred image state.

NOTE 2 Output referred image data are referred to the specified output device and viewing conditions. A single scene can be colour rendered to a variety of output-referred representations depending on the anticipated output viewing conditions, media limitations and/or artistic intents.

NOTE 3 Output-referred image data can become the starting point for a subsequent reproduction process. For example, sRGB output-referred image data are frequently considered to be the starting point for the colour re-rendering performed by a printer designed to receive sRGB image data.

3.17
scene
spectral radiances of a view of the natural world as measured from a specified vantage point in space and at a specified time

NOTE A scene can correspond to an actual view of the natural world or to a computer-generated virtual scene simulating such a view.

3.18
scene-referred image state
image state associated with image data that represents estimates of the colour space coordinates of the elements of a scene

NOTE 1 When the phrase "scene-referred" is used as a qualifier to an object, it implies that the object is in a scene-referred image state. For example, scene-referred image data are image data in a scene-referred image state.

NOTE 2 Scene-referred image data can be determined from raw DSC image data before colour rendering is performed. Generally, DSCs do not write scene-referred image data in image files, but some do so in a special mode intended for this purpose. Typically, DSCs write standard output-referred image data where colour rendering has already been performed.

NOTE 3 Scene-referred image data typically represents relative scene colourimetry estimates. Absolute scene colourimetry estimates can be calculated using a scaling factor. The scaling factor can be derived from additional information such as the image OECF, FNumber or ApertureValue, and ExposureTime or ShutterSpeedValue tags.

NOTE 4 Scene-referred image data can contain inaccuracies due to the dynamic range limitations of the capture device, noise from various sources, quantization, optical blurring and flare that are not corrected for, and colour analysis errors due to capture device metamerism. In some cases, these sources of inaccuracy can be significant.

NOTE 5 The transformation from raw DSC image data to scene-referred image data depends on the relative adopted whites selected for the scene and the colour space used to encode the image data. If the chosen scene adopted white is inappropriate, additional errors will be introduced into the scene-referred image data. These errors can be correctable if the transformation used to produce the scene-referred image data are known, and the colour encoding used for the incorrect scene-referred image data has adequate precision and dynamic range.

NOTE 6 The scene can correspond to an actual view of the natural world, or be a computer-generated virtual scene simulating such a view. It can also correspond to a modified scene determined by applying modifications to an original scene to produce some different desired scene. Any such scene modifications need to leave the image in a scene-referred image state and need to be done in the context of an expected colour rendering transform.

3.19
tristimulus value
amounts of the three reference colour stimuli, in a given trichromatic system, required to match the colour of the stimulus considered

[CIE Publication 17.4:1987, 845-03-22]

3.20
veiling glare
light, reflected from an imaging medium, that has not been modulated by the means used to produce the image

NOTE 1 Veiling glare lightens and reduces the contrast of the darker parts of an image.

NOTE 2 In CIE Publication 122, the veiling glare of a CRT display is referred to as ambient flare.

3.21
viewing flare
veiling glare that is observed in a viewing environment but not accounted for in radiometric measurements made using a prescribed measurement geometry

NOTE The viewing flare is expressed as a percentage of the luminance of adapted white.

3.22
working colour space
colour space encoding in which operations such as image edits, enhancements, or colour rendering are performed

NOTE 1 The image state in a working colour space can change as operations are performed.

NOTE 2 If operations performed in a working colour space are guided by viewing the image on a medium, that medium and the associated viewing conditions become the reference for the resulting image.

4 Requirements

4.1 General

Reference input medium metric RGB (RIMM RGB) and the ERIMM and FP-RIMM associated versions of RIMM RGB are extended colour gamut RGB colour image encodings of the colourimetry of a scene-referred image, white balanced to be relative to a specified adopted white. The image colourimetry is encoded in terms of an additive RGB colour space associated with a hypothetical additive colour device having a specified set of primaries and no cross-talk between the colour channels. The RIMM RGB colour image encoding has a maximum luminance value corresponding to 200 % of a perfect diffuse reflector (i.e. an observer adaptive luminance factor of 2,0). Extended reference input medium metric RGB (ERIMM RGB) is an extended luminance dynamic range version of RIMM RGB having a maximum observer adaptive luminance factor of about 316. The maximum luminance value of FP-RIMM RGB colour image encoding is

